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THE DEVELOPMENT OF AUDITORY PERFORMANCE STANDARDS FOR NAVAL AVIATORS: RADIOCOMMUNICATIONS QUESTIONNAIRE RESULTS

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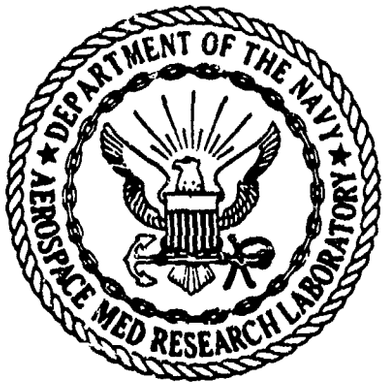

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The establishment of hearing standards for naval aviators requires some determination of acceptable or normative performance in the operational environment. Because speech perception via radio link is the principal auditory ability required of aviators, questions regarding several aspects of radiocommunications were asked of 62 experienced aviators stationed at NAS Oceana. Respondents to the questionnaire provided information regarding the frequency and cause of missed communications, the types of aircraft and flight scenarios in which communications are particularly difficult, their use of hearing protection, et cetera. The aviators reported that 1) across aircraft, an average 24% of all radiocommunications are missed, and 2) the principal causes included co-channel interference, cockpit noise, and poorly functioning equipment. Radiocommunications were reported to be most difficult in the F-14 with its noisy environmental control system (ECS). Improvements suggested by the respondents (e.g., a better fitting face mask, improved helmet noise attenuation, lower ECS noise levels, etc.) are all areas worthy of attention and within the capabilities of current technology.

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SUMMARY PAGE

THE PROBLEM

No data are presently available regarding normative radiocommunications performance in the cockpit. That is, we do not know how frequently radio-communications are missed or why they are missed. Because voice communication via radio link is a primary auditory skill required of aviators and because we are striving to ascertain some minimal level of acceptable performance for use in setting new auditory standards, a radiocommunications questionnaire was administered to several groups of experienced naval aviators.

FINDINGS

The results of the questionnaire administered to 62 experienced naval aviators revealed that between 5 and 30% of all radiocommunications in the operational environment are missed to the extent that a repeat of the message is requested. Cockpit noise, poor signal quality, and co-channel interference were cited as the principal causes of missed communications. The F-14 environmental control system (ECS) was repeatedly mentioned as being particularly effective in masking voice communications. Radiocommunications were also affected by flight scenario with dynamic maneuvering situations being noted as most disruptive. Suggestions for improved radiocommunications included cockpit noise reduction, improved masks that do not restrict jaw movement, state-of-the-art radio electronics, and reduced use of the guard frequency.

Acknowledgments

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INTRODUCTION

As part of a Naval Aerospace Medical Research Laboratory (NAMRL) effort to establish new hearing standards for naval aviators, we found it necessary to gain some insight into normative aviator operational performance with respect to radiocommunications. That is, we wanted answers to such questions as, "How frequently are radiocommunications (radiocomms) routinely missed in the operational environment?" and "When radiocomms are missed, why are they missed?" We sought this information about radiocommunications performance to aid us in setting initial performance screening criteria and because the reception of radiocommunications is the principal auditory skill required of aviators. The purpose of the present study, therefore, was to ascertain "real life" radiocommunications performance in the cockpit and obtain information relevant to minimally acceptable performance. In addition, we solicited pilots' opinions regarding needed areas of radiocommunications improvements.

METHOD

A total of 62 experienced aviators (2103 mean flight hours, 10.1 mean years in service) currently flying in tactical aircraft at the Air Combat Maneuvering (ACM) range at NAS Oceana anonymously completed a multi-item radiocommunications questionnaire. Of the 62 volunteer respondents, 32 were currently flying F-14 aircraft, 19 were flying A-4 aircraft, and 11 were flying F-5 aircraft.

The questionnaire requested personal information, statements regarding the use of hearing protection, opinions relative to radiocommunications improvements, and ratings on a five-part semantic differential scale concerning operational conditions. Responses on the semantic differential scale were measured in inches from the left terminus and were averaged to arrive at final values. The questionnaire and mean ratings are shown in the following section. Specific frequency counts for responses involving commentary are not provided; rather, because most expository responses contained multiple points, representative responses were chosen and are listed according to their approximate frequency of occurrence.

RADIOCOMMUNICATIONS QUESTIONNAIRE AND RESPONSES

PERSONAL INFORMATION

Name (optional)_____

Rank_____

Navy Occupational Billet Code_____ Years in Service_____

Flight Hours (total)_____

Type of aircraft presently flying (and to which the answers on this questionnaire refer)

_____.

1. In the course of in-flight operations, about what percentage of radio voice communications are unintelligible to the point where a "repeat" or other action (e.g., change of channel) is required?

A-4 = 5%
F-5 = 23%
F-14 = 30%
Total = 24%

For Question 2, please place an "X" on the line representing the continuum from "Never" to "Always"

For example,

I----------X----------I

0%	25%	50%	75%	100%
Never	Infrequently	Sometimes	Frequently	Always

Note: The following responses are the means for each type of aircraft.
X = A-4 O = F-5 # = F-14

2. Of those unintelligible communications referred to in Question 1, about how frequently are they due to the following causes?

   a. High level of cockpit noise ---

   I-------X----------O----------#----------I
   Never Infrequently Sometimes Frequently Always

   b. Degradation of signal by atmospheric noise (i.e., static) ---

   I----------#XO----------I
   Never Infrequently Sometimes Frequently Always

   c. Poor equipment condition (e.g., poor modulation, intermittency of operation, etc.) ---

   I----------#----------O----X----------I
   Never Infrequently Sometimes Frequently Always

   d. Weak signal (not caused by cockpit or atmospheric noise) ---

   I----------#XO----------I
   Never Infrequently Sometimes Frequently Always

   e. Interference to the signal by other voices on the channel ---

   I----------#-X-O----------I
   Never Infrequently Sometimes Frequently Always

f. Intentional electronic jamming ---

I--------#XO----------I
Never Infrequently Sometimes Frequently Always

g. Signal distortion of unknown origin ---

I---------O#----------X----------I
Never Infrequently Sometimes Frequently Always

h. Unclear speech by the talker (e.g., unfamiliar dialect or accent, poor enunciation, etc.) ---

I----------O----------#----X----------I
Never Infrequently Sometimes Frequently Always

i. Lack of attention by the listener ---

I----------O---X---#----------I
Never Infrequently Sometimes Frequently Always

j. Other (please describe) ---

-"mostly due to ICS/2 radios in a/c'; if both go at once, you miss transmissions"
-"F-14 ECS is extremely loud and causes missed calls!"
-"guard transmission occurring at same time as UHF"
-"ALR 45 + 55 tones always too loud"

3. What do you typically do when a contact is unintelligible?

-"ask for repeat"
-"ask radar officer if he received"

4. Are there any specific aircraft or radio equipment which you've noticed as being particularly troublesome in the communication of voice signals?

No 51% Yes 49%

If Yes, which ones?

-"F-14 ECS particularly loud and distracting"
-"oxygen mask not allowing acceptable jaw movement"
-"headset noise insulation poor"
-"ATIS recording usually poor"
-"hot mike overwhelms"

5. Are there particular flight scenarios where voice communications tend to be difficult?

No 17% Yes 83%

If Yes, which ones?

-"under dynamic maneuvering such as ACM"
-"in high tasking/low altitude scenarios when attention is outside the cockpit"
-"under high-G with loud ECS and hot mike selected, masks slip and ambient noise makes comm difficult"
-"heavy traffic"
-"comm jamming situations"
-"when two radios are required"
-"bad weather"
-"attention divided between aural and visual"

6. What type of hearing protection do you typically use during flight?

80% Standard issue helmet and phones
0% Plugs
20% Non-standard issue helmet and/or phones (please describe) ---

-"Protection, Inc. formfit helmet"
-"formfit helmet"

---

[1] aircraft

7. In your opinion, how should the technical and scientific communities use resources to improve radiocommunications?

71% Improve electronic equipment
22% Develop operator training/speaking programs
40% Other (please explain)
-"reduce noise levels of F-14 ECS"
-"improve masks, mikes, and helmet insulation to a/c noise"
-"build some state of the art radios to replace 10-20 year old ones"
-"make cockpits quieter"
-"screen radiocomm operators for 'quality' of voice"
-"F-14 radio system is such that front cockpit volume set for receiving UHF transmissions is too low to hear RIO cockpit"

8. Any other comments you might make regarding radio voice communications would be appreciated ---

-"biggest problem in ftr[2] community is F-14 ECS; this will cost a/c and lives in real combat"
-"there are far too many non-essential comms performed on guard frequency"
-"would like radio controls situated so that I don't have to lower my head [and] come into the cockpit to verify settings"
-"Navy needs a two radio system in all tactical jets now; either 2 UHF or UHF/VHF"
-"requisite to intelligible transmissions is a mask that fits and doesn't restrict jaw movement"
-"formfit masks would help tremendously"

DISCUSSION

The results of the preceding questionnaire indicate that missed radiocommunications in tactical situations may be more frequent than we had originally anticipated. The F-14's noisy ECS system was, by far, the most frequently cited cause of missed radiocommunications. Across aircraft, co-channel interference was dominant, with poor signal quality at the ear (e.g., weak signals, unclear speech, poor equipment) also contributing to missed radiocommunications. "Lack of attention" due to high tasking demands, too, was responsible for unsuccessful communications.

[2] fighter

Improvements suggested by the respondents (e.g., a better fitting face mask, improved helmet noise attenuation, lower ECS noise levels, etc.) are all areas worthy of attention and within the capabilities of current technology. Similarly, tighter control of guard frequency usage and, perhaps, "clear speech" training would also prove beneficial.

With the preceding information, we now have insights into some of the radiocommunications problems which pilots face in the operational environment. This will allow us to not only construct simulated operational environments reflective of "real world" conditions but also to set initial levels of acceptable auditory performance.

Other Related NAMRL Publications

Thomas, G.B., Williams, C.E., and Raney, J., The Development of Performance-based Auditory Aviation Classification Standards in the U.S. Navy, NAMRL-1355, Naval Aerospace Medical Research Laboratory, Pensacola, FL, December 1987.